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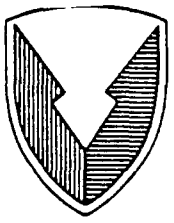

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The Role of EEPROM Devices in Upcoming ISDN Applications

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February 1991

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Integrated Services Digital Network (ISDN) equipments are rapidly becoming a major market for semiconductor chips. Although at first glance this growing market appears to be geared at logic chips, nonvolatile memories represent important support chips and will become a significant segment of this market. Challenges in these applications consist in operating EEPROMs at lower voltages and lower power and embedding them on ever more complex communications processor chips.

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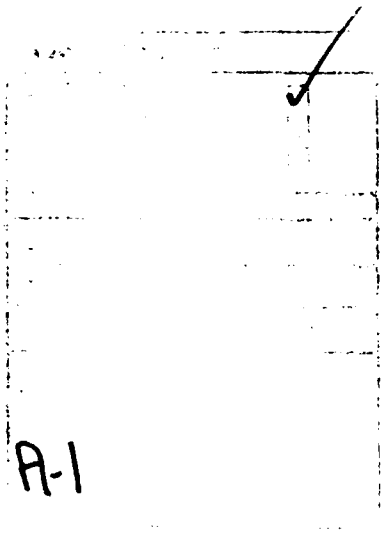

INTRODUCTION

During the next decade, telecommunications networks worldwide will become digitized and chip manufacturers are rushing to meet this huge developing market. One of the most promising services, the Integrated Services Digital Network (ISDN) has been under discussion for 20 years, but only recently have standards been agreed upon that permit the development of terminals and operation of public services. ISDN is designed to transport digital voice and data signals simultaneously over a single channel. Starting in the mid-1970s, the UN sponsored International Consultive Committee for Telephone and Telegraph (CCITT) began a study of and later established international standards for ISDN. This report will evaluate the role of nonvolatile semiconductor memories, notably EPROMs and EEPROMs, in this emerging market.

ISDN STANDARDS

Basic Rate ISDN, sometimes also referred to as Narrowband ISDN, is structured in the 2B+D format (2 64-kbps voice or data channels and 1 16-kbps data channel for signaling, packet and telemetry information). ISDN is based upon synchronous fixed channel techniques for twisted wire pairs. The B-Channels represent user -information channels and provide simultaneous transmission for speech, data, text, and FAX. The D-channel provides a high performance signaling channel separate from the user information channels.

According to recommendations, adopted at the IXth CCITT Plenary Assembly, 14-25 November 1988 in Melbourne, Australia: in normal active mode, an ISDN terminal may not use more than one watt of power. In deactivated operation in the normal mode, the terminal may not use more than 100 mW. In the restricted mode (emergency or when no other source of power is available), CCITTs I.430 document requires that one designated terminal must be available and must not use more than 380 mW when activated, and only 25 mW when deactivated. In ISDN equipments, this requirement favors the use of nonvolatile semiconductor memories, such as EPROMs or EEPROMs which store information without power dissipation; and, in particular, those types that can be read, erased and programmed at minimum power levels. This includes memories which are embedded on microcontrollers.

STATUS OF IMPLEMENTATION

In most countries, the introduction of ISDN is application driven, rather than technology driven. One of the most popular applications is Automatic Number Identification (ANI), using ISDN E-channels. Other applications are: terminal to terminal communications, file sharing, and Local Area Network (LAN-to-LAN) interconnections.

U.S.

ISDN-based CENTREX service is currently available from telcos in several metropolitan areas throughout the U.S. Among the long distance carriers, MCI plans to go all-digital by 1994, while Sprint is already fully digital. More than 60 U.S. companies have already moved to ISDN, including 3M, Boeing, Citicorp, Liberty Mutual and Weyerhauser.

Europe

In several European countries, ISDN is even further ahead. France, e.g., has now achieved almost full geographical coverage. Moreover, in Europe a memorandum of understanding was signed in 1988 by the 12 EC countries and six others to provide common ISDN services by 1992.

Japan

In Japan, NTT is aggressively converting the system to a digital network with a goal of 1995 for national coverage, and completion of a national digital network by the year 2000.

Trans-Continental

The establishment of fiber optic cables across the Atlantic and Pacific has made it possible to establish intercontinental ISDN among the U.S., Japan and the United Kingdom.

Military

In Europe, NATO has developed the concept to adapt commercial ISDN for military purposes in what is called 'NATO ISDN' or NISDN. This network will provide services to national military and civilian subnetworks, as well as specific NATO resources.

ISDN CIRCUIT FUNCTIONS AND EQUIPMENTS

ISDN equipments fall roughly into two categories: terminal adapters that permit connecting existing equipments to ISDN networks and complete ISDN equipments such as digital telephones.

By matching data and text to the ISDN interface, thereby completely replacing modems, ISDN terminal adapters are needed only for a transition period to avoid making existing non-ISDN equipment obsolete.

PCs can be made to serve as ISDN terminals through an ISDN interface card. Such boards are inserted into an expansion slot of the PC and allowed to receive data at all times even when another task is in progress. ISDN boards are usually microprocessor-based, contain nonvolatile memories on-chip or off-chip and are designed to handle both analog and digital signals with mixed signal VLSI parts. Through ISDN, PC users can access and share files or printers located on other PCs in much the same way as if they were connected via traditional LANs.

At the heart of ISDN's growth will be the ISDN workstation, which consists of:

A simple ISDN handset
An advanced IC
An ISDN basic access PC card
Other elements such as FAX

A typical ISDN terminal control circuit combines the following functions:

Subscriber Controller
EEPROM or EPROM
SRAM
Microcontroller
Power Controller

The following are some of the ISDN control devices being offered by various vendors:

29C48 Codec/Filter	Intel
29C53 S/T Transceiver	Intel
Digital Subscriber Controller	AMD
S/T Interface Transceiver	AMD
D-Channel Datalink Controller	AMD
Audio Codec Filter	AMD
ISDN Controller	Siemens
PCM Interface Controller	Siemens
U-Interface Chip	Siemens
S-Interface Transceiver	Thomson/National
Programmable Combo (Codec/Filter)	Thomson/National

Alternative S-Interface Circuit	Thomson/National
U-Interface Transceiver	AT&T
U-Interface Transceiver	Motorola
Line Driver Receiver	Toshiba

Other vendors in the field are Hayes, NCR, Progressive Computing, Vadis Inc. and Teleos.

ROLE OF NONVOLATILE MEMORIES IN ISDN TERMINALS

Nonvolatile memories such as EEPROM and EPROM play an increasing role in both terminal adapters and ISDN equipments, and in digital PBXs for implementing network control functions such as:

- Phone book lookup capability
- Self dialing
- Security access coding
- Retain programming instructions in switch
  (EPROM used on AT&T control cards)
- Digital telephone cards to support 64-kbps
- Systems configuration unit (SCU)in digital PBXS
  in EPROM or EEPROM
- Memory cards in multifunction communications terminals
  (Mitsubishi)
- Store ISDN-compliant code for core microprocessor
- User configuration of terminal adapters
- Store application specific configuration in terminals

For example, the Hitachi HN29C101 1Mb Flash EEPROM has been designed for self-dialing. AT&T uses EPROM chips on the control cards to retain programming instructions in PBXs. Similarly, the Prodigy PBX installed by Moorgate Funding Ltd of Las Vegas consists of a digital telephone switch which stores the entire operating system in ROM, but has the system configuration information stored in easily updated EPROM. On the other hand, the Harris D1200 Series digital PBX which previously used an EPROM based system configuration capability has now been redesigned for a SEEQ 52B13 EEPROM CHIP.

CHALLENGES FOR EEPROM DESIGNERS

Some of the challenges for EEPROM designers in the ISDN environment include:

1. Integrating EEPROM on high density communications controller chips.

2. Since CCITT power specifications allow ISDN terminals to be powered from the telephone line, this, as well as portability, demands a new generation of nonvolatile memories and circuitry that operates at 3 V and very low power. (Note: Present ASCII specifications call for a pk-pk input signal voltage for telephone transmission lines of only 4 volts.)

NEC has started marketing the fPD75048, a 4-bit microcontroller with built-in 4-kbit EEPROM which can operate at as low as 2.7 V, and is designed for telephone equipment.

IMPLICATION FOR FUTURE WIDE-BAND ISDN

In addition to Basic Rate ISDN, standards have been developed for Primary Rate ISDN, which offers wider bandwidth. In North America and Japan, the PRI circuit has 23 B channels (23B+D), in Europe and the rest of the world 30 (30B+D) channels. In PRI, both the B and D Channels have a capacity of 64 kbps.

Broadband ISDN (B-ISDN), as projected now, differs from Narrowband ISDN in that it provides dynamically configurable channels or packets at rates up to 150 Mbps transmitted via an optical interface. Additional interface rates up to 600 Mbps or higher are also being discussed. Although much of the control circuitry for this equipment will require GaAs or BiCMOS devices, nonvolatile storage devices are still required for some support functions.

SIZE OF ISDN CHIP MARKET

Estimates of the size of the ISDN equipment market vary greatly between forecasters, reflecting uncertainty in consumer acceptance of these devices. The following figures for U.S. shipments of ISDN terminals were quoted in Computerworld:

Year	Mil$	
1989	34	
1991	293	
1994	2,219	Growth Rate: 130.7%

Other sources peg the total U.S. Market for end user equipment closer to $5 Bil by 1994. This growth is linked to the growth in ISDN access lines by the seven telcos.

By 1994, close to 2% of the telephone lines served by the seven Bell regional holding companies (RHC) will be able to deliver ISDN services. By region this will be:

Company	ISDN Lines	Total Lines	%ISDN
Pacific Telesis	42,210	16 Mil	0.26
BellSouth	1,600,000	20 Mil	7.9
Ameritech	140,000	20 Mil	0.7
Bell Atlantic	312,000	26 Mil	1.2
Nynex	750,000	25 Mil	0.3
Southwestern Bell	128,000	20 Mil	0.64
U.S. West	90,000	20 Mil	0.45
Total:	3,062,210	147 Mil	

The average growth rate in ISDN lines is expected to be 45% per year. Note that BellSouth projects the largest percentage of ISDN lines by 1994.

Internationally, the anticipated market for network facilities and terminals is significant. By 1996, the market will be dominated by Europe, which will hold 51.4% of the market, followed by the U.S. with 38.5% and the rest of the world with 10.1% of global demand.

In Japan, NTT plans to invest Y500 Bil ($4 Bil) annually for 11 years. If ISDN is extended to all telephone users in Japan, the demand for terminals would be Y12.5 Trillion (or $100 Bil).

Much of the cost of ISDN terminals is in the cost of ISDN chips. According to In-Stat, total North American and European Sales in ISDN chips will increase to $661 Mil by 1992 and $3 Bil by 1995. The share of EPROM and EEPROM chips, including embedded memory on microcontrollers and digital signal processors, may be estimated at 15% and thus result in North American and European sales growth from $100 Mil in 1992 to $450 Mil in 1995.

The significance of the telecommunications market for chip manufacturers is already evident. For example, Philips reports that 30 to 40% of their Flash EEPROM customers are telecommunications companies.

To meet the growing demand in ISDN chips, strategic alliances have been formed among manufacturers to strengthen their position. These include: National Semiconductor and SGS Thomson, AMD and Siemens, Motorola and Northern Telecom, Inc.

CONCLUSIONS

ISDN equipments are rapidly becoming a major market for semiconductor chips. Although this growing market at first glance appears to be geared at logic chips, nonvolatile memories represent important support chips and will become a significant segment of this market. Challenges in these applications consist in operating EEPROMs at lower voltages and lower power and embedding them on ever more complex communications processor chips.

REFERENCES

ISDN developments are being closely monitored in a number of newsletters, including:

ISDN News, Phillips Publishing Inc. Biweekly.

Intelligent Network News, Telecom Publishing Group, Capitol Publications Inc. Monthly.

Edge, Edge Publications/OA Systems, Inc. Weekly.

Communications Daily, Warren Publishing, Inc.

Newsbytes News Network. Daily.

Some pertinent articles on the subject have appeared in magazines including:

1. Joseph J. Spadero, "Updating the Action in ISDN ICs," Electronic Products, September 1, 1988, p. 33-36.

2. Milt Leonard, "ISDN: Approaching the End of the Tunnel - VLSI Solutions to ISDN Attack the Last Barriers to Global Deployment," Electronic Design, January 25, 1990, p. 45-50.

3. Jon Gabay, "Proliferating ISDN Parts May Spell Confusion," High Performance Systems, August 1989, p. 18-19.

4. Louis Stilp, "ISDN: Making a Plan into a Network," Telecommunications, May 1988, p. 41-46.

5. Alan Stewart, "A User's Guide to ISDN Standards," Telecommunications, May 1988, p. 34-46.

6. Ellen G. Block, "The Telcos Are Ready, But Are the Users?," Telecommunications, May 1989, p. 31-40.

7. Horst Edgar Martin, "ISDNs: The Network Solution of the Future," Telecommunications, September 1986, p. 69-82.

8. Max Jensen, "Making PCs 'ISDN Ready'," Telecommunications, March 1990, p. 64-65.

9. Stephan Timms, "The Outlook for ISDN Customer-Premises Equipment," Telecommunications, December 1988, p. 58-62.

10. Milt Leonard, "U-Interface Transceiver Integrates Analog and DSP," Electronic Design, October 12, 1989, p. 45-48.

11. Roger Woolnough, "ISDN Pieces Fall in Place," Electronic Engineering Times, April 9, 1990, p. 18.

12. Frank J. Derfler, Jr., "Is ISDN Tomorrow's Interoffice Network?," PC Magazine, February 13, 1990, p. 229-254.

13. Jon Widdicks and Loren Dietrichsen, "The Significance of the NATO ISDN Concept," Signal, October 1989, p. 37-40.

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